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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	2028-174
First Inventor	Mark J. Kittock
Title	Fluid-Moving Device With A Clearance Seal
Express Mail Label No.	EL399426228US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. [X] Fee Transmittal Form (e.g., PTO/SB/17) *(Submit an original and a duplicate for fee processing)*
2. [ ] Applicant claims small entity status. See 37 CFR 1.27.
3. [X] Specification [*Total Pages* 11] *(preferred arrangement set forth below)*
   - Descriptive title of the invention
   - Cross Reference to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to sequence listing, a table, or a computer program listing appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
4. [X] Drawing(s) *(35 U.S.C. 113)* [*Total Sheets* 3]
5. Oath or Declaration [*Total Pages* 3]
   a. [X] Newly executed (original or copy)
   b. [ ] Copy from a prior application (37 CFR 1.63 (d)) *(for continuation/divisional with Box 17 completed)*
      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
6. [ ] Application Data Sheet. See 37 CFR 1.76

ADDRESS TO:	Assistant Commissioner for Patents Box Patent Application Washington, DC 20231

7. [ ] CD-ROM or CD-R in duplicate, large table or Computer Program (*Appendix*)
8. Nucleotide and/or Amino Acid Sequence Submission (*if applicable, all necessary*)
   a. [ ] Computer Readable Form (CRF)
   b. Specification Sequence Listing on:
      i. [ ] CD-ROM or CD-R (2 copies); or
      ii. [ ] paper
   c. [ ] Statements verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

9. [X] Assignment Papers (cover sheet & document(s))
10. [ ] 37 CFR 3.73(b) Statement *(when there is an assignee)* [X] Power of Attorney
11. [ ] English Translation Document *(if applicable)*
12. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
13. [ ] Preliminary Amendment
14. [XX] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
15. [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16. [ ] Other: .....

17. If a CONTINUING APPLICATION, *check appropriate box, and supply the requisite information below and in a preliminary amendment, or in an Application Data Sheet under 37 CFR 1.76:*

[ ] Continuation [ ] Divisional [ ] Continuation-in-part (CIP) of prior application No.: _____/_____

Prior application information: *Examiner* _____ *Group / Art Unit:* _____

For CONTINUATION OR DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

18. CORRESPONDENCE ADDRESS

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Name	22471
	PATENT TRADEMARK OFFICE
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City	State Zip Code
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Name (Print/Type)	Gary T. Hampson	Registration No. (Attorney/Agent)	29,929
Signature		Date	October 09, 2000

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FEE TRANSMITTAL for FY 2000

Patent fees are subject to annual revision

TOTAL AMOUNT OF PAYMENT ($) 730

Complete if Known	
Application Number	
Filing Date	October 10, 2000
First Named Inventor	Mark J. Kittock
Examiner Name	
Group Art Unit	
Attorney Docket No.	2028-174

METHOD OF PAYMENT (check one)

1. [XX] The Commissioner is hereby authorized to charge indicated fees and credit any overpayments to:

Deposit Account Number: 02-1660

Deposit Account Name: Beckman Coulter, Inc.

[XX] Charge Any Additional Fee Required Under 37 CFR 1.16 and 1.17

[ ] Applicant claims small entity status. See 37 CFR 1.27

2. [ ] **Payment Enclosed:**

[ ] Check [ ] Credit card [ ] Money Order [ ] Other

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	690	201	345	Utility filing fee	$690
106	310	206	155	Design filing fee	
107	480	207	240	Plant filing fee	
108	690	208	345	Reissue filing fee	
114	150	214	75	Provisional filing fee	

SUBTOTAL (1) ($) 690

2. EXTRA CLAIM FEES

	Extra Claims		Fee from below	Fee Paid
Total Claims	11 -20** =	0	X 18	= 0
Independent Claims	2 - 3** =	0	X 78	= 0
Multiple Dependent				

**or number previously paid, if greater; For Reissues, see below

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
103	18	203	9	Claims in excess of 20
102	78	202	39	Independent claims in excess of 3
104	260	204	130	Multiple dependent claim, if not paid
109	78	209	39	** Reissue independent claims over original patent
110	18	210	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 0

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for ex *parte* reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	380	216	190	Extension for reply within second month	
117	870	217	435	Extension for reply within third month	
118	1,360	218	680	Extension for reply within fourth month	
128	1,850	228	925	Extension for reply within fifth month	
119	300	219	150	Notice of Appeal	
120	300	220	150	Filing a brief in support of an appeal	
121	260	221	130	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive - unavoidable	
141	1,210	241	605	Petition to revive - unintentional	
142	1,210	242	605	Utility issue fee (or reissue)	
143	430	243	215	Design issue fee	
144	580	244	290	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Petitions related to provisional applications	
126	240	126	240	Submission of Information Disclosure Stmt	$40
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	690	246	345	Filing a submission after final rejection (37 CFR § 1.129(a))	
149	690	249	345	For each additional invention to be examined (37 CFR § 1.129(b))	
179	690	279	345	Request for Continued Examination (RCE)	
169	900	169	900	Request for expedited examination of a design application	

Other fee (specify) _____

* Reduced by Basic Filing Fee Paid

SUBTOTAL (3) ($) 40

SUBMITTED BY				Complete *(if applicable)*	
Name (Print/Type)	Gary J. Hampson	Registration No. (Attorney/Agent)	29,929	Telephone	714-773-6926
Signature	Gary J. Hampson			Date	October 09, 2000

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Fluid-Moving Device with a Clearance Seal

Background of the Invention

Area of the Art

The invention relates generally to fluid-tight dynamic seals between a reciprocating member and its housing. More particularly, the invention is directed to fluid-tight dynamic clearance seals and fluid-moving equipment utilizing such seals.

Description of the Prior Art

In many types of fluid-moving equipment, such as liquid pumps, slurry pumps, dry mixers, and numerous other devices, a sliding plunger, rod, piston, or another similar member, reciprocally moves inside a stationary bearing. Typically, fluid leakage around the moving member is prevented by utilizing sealing structures. The material of the sealing structure is required to have some resiliency and yet some degree of stiffness which will permit the moving member to slide back and forth through the axial opening of the sealing structure and yet be tight enough to prevent or at least minimize leakage of the liquid around the moving member.

One type of a conventional sealing structure is a mechanical face seal. Typically, the mechanical face seal consists of one seal ring rotating with the driving shaft and one stationary seal ring attached to the surrounding housing. The two seal rings are pressed towards each other by a biasing force which, in this way, prevents liquid from passing between them. For example, U.S. Pat. Nos. 3,282,235; 4,754,981; and 5,772,217 describe a seal with a spring for providing the biasing force. Usually, additional elastomeric components are required to seal each ring from the shaft or housing, correspondingly. Typically, a thin lubricating film is required between the seal surfaces to prevent their damage by dry friction. Nevertheless, with time, wear and vibrations cause the mating faces of the sealing rings to become scored, resulting in leakage of the process fluid. Environments where the process fluid is abrasive or contains a coagulant are particularly damaging to the conventional seals and require their frequent replacement.

A packed stuffing box is another example of a conventional seal for a moving member. This type of seal has been disclosed, for example, in U.S. Pat. Nos. 3,659,862 and 5,333,883. Generally, the packing is sufficiently compressed to limit the passage of fluid through the packing, but not so compressed as to create excess friction

between the packing and the moving member. Pressure is generally maintained on the packing by manually tightening a gland on the stuffing box until the point where leakage through the packing is minimized, yet before the point where friction between the packing and the shaft creates overheating of the packing. Such a configuration operates on the principle of controlled leakage to the atmosphere rather than zero leakage. However, this requires frequent adjustment, and over tightening results in excess friction and heat buildup, excessive wear to the packing, and possibly even damage to the moving member. Even when the pressure on the packing is properly regulated, the pressure necessary to minimize the passage of fluid through the packing causes relatively high friction between the packing and the shaft. As a result, the packing wears out quickly and requires a frequent replacement.

Finally, referring to Figure 1, a combination of an elastomeric O-ring **1** with a spring preloaded polymer seal **2** has been utilized in the past to create a dynamic seal between a moving member, such as a piston **3**, and a housing structure. For example, Beckman Instruments (Fullerton, CA) uses this arrangement in the Access Immunoassay Analyzer. Typically, the housing structure includes a casing **4** and a piston-supporting bearing **5**. The polymer seal **2** prevents the fluid from flowing between the piston **3** and the bearing **5**, while the O-ring **1** seals off the housing. A preloading spring **6** forces the polymer seal **2** to squeeze directly on the piston **3** to accomplish the seal, thus resulting in wear of the polymer. The speed of the moving member and the fluid being sealed determines the required frequency of the polymer seal replacement.

Apparently, the sealing structures of prior art do not provide reliable and long-lasting seals between moving members and their housing. The conventional seals undergo a lot of wear during normal operation and have to be replaced frequently. The necessity to replace seals makes prophylactic maintenance of the equipment more laborious and increases its maintenance costs.

Summary of the Invention

Accordingly, it is an object of the present invention to provide improved seals which avoid the undesirable features of the prior seals. Particularly, it is an object of the present invention to provide seals which have a low wear, may be produced at relatively low costs, and provide superior performance in use. It is a further object of the present invention to provide convenient fluid-moving devices utilizing such seals with relatively low maintenance cost and high reliability.

These and other objects are achieved in a clearance seal assembly of the present invention. The assembly comprises a stationary member defining a first side, a second side and an opening connecting the first and second side; a moving member moveably disposed through the opening; and a sealing member circumferentially disposed between the stationary member and the moving member. The sealing member has a fluid-tight relationship with the stationary member. The sealing member and the moving member define a continuous and uniform gap, having a size that allows the fluid to fill the gap but prevents the fluid from flowing through the gap from the first side to the second side of the opening under an operating pressure differential between the first and the second side. In a preferred embodiment, both the sealing member and the moving member are made of a ceramic material. The sealing assembly may also include a static seal disposed between the stationary member and the sealing member to allow a variable clearance therebetween while maintaining the fluid-tight relationship between the sealing member and the stationary member.

In another aspect, the invention provides a pump utilizing a clearance seal assembly. The pump comprises a housing structure having an internal wall defining a suction chamber for containing a fluid; a piston movably disposed within the chamber; and a sealing member circumferentially disposed between the housing structure and the piston. The sealing member has a fluid-tight relationship with the housing structure. The sealing member and the piston define a continuous and uniform gap. The gap has a size that allows the fluid to fill the gap but prevents the fluid from flowing through the gap from the suction chamber to an outside of the chamber under an operating fluid pressure.

By eliminating a direct contact between the sealing member and the moving member, the present clearance seal assembly alleviates many of the problems

associated with the conventional seals discussed above. In particular, the advantages of this approach include a minimal wear of the part, simplified assembly and maintenance, significantly improved reliability, and a decreased maintenance cost. The clearance seal of the present invention may be utilized in any device or system that requires drawing, moving, and dispensing of fluids. The invention may be particularly advantageous for use in high-precision pumps employed in analytical instrumentation. For example, a piston pump with a clearance seal manufactured in accordance with the present invention may be beneficially utilized for sample aspiration and dispensing in Nexgen Access System (Beckman Instruments, CA), disclosed in a U.S. patent application titled "Method and System for Automated Immunochemistry Analysis," which has been commonly assigned to the assignee of the present invention and relevant parts of which are incorporated by reference herein.

The invention is defined in the appended claims and is described below in its preferred embodiments.

Description of the Figures

The above-mentioned and other features of this invention and the manner of obtaining them will become more apparent, and will be best understood by reference to the following description, taken in conjunction with the accompanying drawings, in which:

Figure 1 is a cross-sectional view of a conventional piston seal assembly.

Figure 2 is a cross-sectional view of a clearance seal, according to one embodiment of the present invention.

Figure 3 is a cross-sectional view of a clearance seal, according to another embodiment of the present invention.

Detailed Description of the Preferred Embodiments

A conventional seal assembly **10** of a piston pump is shown in Figure 1. Typically, the piston pump includes a housing structure defining a suction chamber **100**. The housing structure includes a stationary casing **4** and a stationary piston-supporting bearing **5**. A piston **3** reciprocates within the suction chamber and is supported by the bearing **5** circumferentially disposed between the casing and the piston. The conventional seal assembly includes a spring-preloaded polymer seal **2** disposed between the bearing **5** and the piston **3**. A preloading spring **6** forces the polymer seal **2** to squeeze on the piston **3** and the bearing **5** to form two sealing points,

7A and **7B**, and to prevent a fluid from leaking into a clearance **8** between the piston and bearing. Typically, an additional elastomeric O-ring **1** is placed under a compression between the bearing **5** and the casing **4**. The O-ring forms a sealing point **9A** with the bearing and a sealing point **9B** with the casing to prevent the fluid from running into a clearance **11** between the bearing and the casing. Consequently, the fluid fills the clearances **12** and **13** of the suction chamber **100**, but cannot flow into clearances **8** and **11** on the outside of the chamber. However, as discussed above, due to the required contact between the stationary polymer seal **2** and the moving piston **3** at the sealing point **7A**, the conventional seal assemblies suffer from rapid deterioration of the polymer seals and require their frequent replacement.

The present invention solves the problems of the prior art by providing a clearance seal, which does not require a direct contact between the piston and the sealing member. The clearance seal assembly of the present invention may be used in an association with any device having a stationary member with an opening and a moving member reciprocating through the opening. Examples of such devices include, but are not limited to, dispensing pumps, slurry pumps, and impeller pumps, used in a broad range of applications. The moving member may be, for example, a sliding plunger, rod, or piston. While a particular configuration of the invention may take on different or modified forms, a piston pump will be used to illustrate the invention in more detail.

Referring to Figure 2, a piston pump with a clearance seal assembly **20** of the present invention includes a stationary housing structure **21** with an internal wall **22** defining a suction chamber **23** for containing a fluid being pumped. A piston **24** is movably disposed within the suction chamber. A sealing member **25** is circumferentially disposed between the housing structure **21** and the piston **24** and has a fluid-tight relationship with the housing structure. The sealing member and the piston define a continuous and uniform gap **26**. The gap **26** has a size that allows the fluid to fill the gap but prevents the fluid from flowing through the gap from the suction chamber to an outside of the chamber under an operating fluid pressure.

In this specification, "a fluid-tight relationship" between two structural elements means that the fluid cannot pass therebetween. It would be appreciated by those skilled in the art that any sealing method between the sealing member **25** and the

housing structure **21** may be used, as long as it provides a reliable seal. For example, in one embodiment shown in Figure 2, a fluid-tight relationship between the sealing member **25** and the housing structure **21** is accomplished by utilizing a removable elastomeric seal, such as an O-ring **27**. In another embodiment shown in Figure 3, the sealing member **25** is integrally formed with the housing structure **21.** In this embodiment, the sealing member may be molded together with the housing from the same material. Alternatively, the sealing structure may be made of a different material than the housing structure and attached to the housing. Means and methods of attachment of two members are well-known in the art and will not be discussed.

Referring to Figure 2, in this specification, a "continuous gap" means that the sealing member and the piston do not have any points of direct contact. A "uniform gap" means that the distance between the piston and an internal wall **28** of the sealing member does not vary significantly so as to compromise the hydraulic seal formed therebetween. It would be appreciated by those skilled in the art, that such a uniform gap requires closely controlled radial dimensions of an outer wall **29** of the piston and the internal wall **28** of the sealing member and a high assembling precision. Consequently, to simplify the control of the critical gap **26**, in the preferred embodiment, the cross-sections of the internal and the outer walls **28** and **29** have substantially circular shapes. Materials that have a high hardness and can be machined with a great precision may be used to make the sealing member and the piston and would be known to those of ordinary skill in the art in view of this disclosure. In one embodiment, both the sealing member and the piston are made of ceramic materials.

It is an unexpected discovery by the present inventors that a fluid seal can be formed between a moving and a stationary member without a direct contact therebetween. It has been observed that the size of the gap **26** may be selected to allow the fluid to fill the gap between the seal and piston, thus avoiding a dry friction, but to prevent the fluid from flowing through the gap. It may be hypothesized, that when the clearance gap is sufficiently small, the adhesive forces of the fluid toward the piston and the seal are greater than the force exerted by the fluid due to an operating pressure, thus preventing the fluid from flowing through the gap.

The ranges of suitable sizes of the gap **26** depend on the physical properties of the fluid being pumped, such as viscosity, surface tension, adhesive force, and operating pressure. Low viscosity fluids will typically require a smaller gap **26** than

higher viscosity fluids. Generally, the higher viscosity of a fluid, the broader range of the gaps **26** may be used. It should be recognized that the size of the gap greatly depends on a type of application. Those skilled in the art can easily select the size of the gap to accommodate fluids and operating pressures used in a particular application without undue experimentation in view of the instant disclosure.

The housing structure **21** of the pump of the present invention may include a casing **21A** defining the suction chamber **23** for accommodating the piston **24**, and a bearing **21B**, circumferentially disposed between the piston and the casing to support the piston. A static seal **27** may be further disposed between the casing and the sealing member to provide a fluid-tight relationship between the casing and the sealing member. Preferably, the static seal member is an annular elastomeric seal removably mounted under compression, forming a sealing point **31A** with the casing and a sealing point **31B** with the sealing member. Comparing Figures 1 and 2, it is apparent that the sealing assembly of the present invention is more reliable as it has fewer contact sealing points, which are potential sources of fluid leaks. Referring to Figure 2, it should be understood that a precise position of the static seal **27** is not important, as long as it prevents fluid from flowing between the housing structure and the sealing member.

Although the invention is described with a particular reference to a piston pump, it should be recognized that the general features of the clearance seal may be utilized in any device having a stationary member, such as the housing structure **21**, with an opening, such as suction chamber **23**, and a moving member, such as piston **24**, moveably disposed through the opening. Generally speaking, the stationary member may have any shape so long as it defines two volumes, such as inside and outside of the pump, referred to as two sides of the stationary member, and connected by the opening. The two volumes may contain different fluids and/or be under different pressure (e.g. operating fluid pressure inside the pump and atmospheric pressure outside the pump).

The present invention may be embodied in other specific forms without departing from its essential characteristics. The described embodiment is to be considered in all respects only as illustrative and not as restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing

description. All changes which come within the meaning and range of the equivalence of the claims are to be embraced within their scope.

What is Claimed is:

1. A clearance seal assembly comprising:

a stationary member defining a first side, a second side and an opening connecting the first and second side;

a moving member moveably disposed through the opening; and

a sealing member circumferentially disposed between the stationary member and the moving member, the sealing member having a fluid-tight relationship with the stationary member, wherein the sealing member and the moving member define a continuous and uniform gap, having a size that allows the fluid to fill the gap but prevents the fluid from flowing through the gap from the first side to the second side of the opening under an operating pressure differential between the first and the second side.

2. The clearance seal assembly of claim 1, wherein the sealing member and the moving member are made of ceramic materials.

3. The clearance seal assembly of claim 1, wherein the gap is defined by an internal wall of the sealing member and an outer wall of the moving member, and cross-sections of the internal and the outer walls have substantially circular shapes.

4. The clearance seal assembly of claim 1, wherein the sealing member is integrally formed with the stationary member.

5. The clearance seal assembly of claim 1, wherein the sealing member is a separate element from the stationary member, the seal assembly further comprising a static seal disposed between the stationery and the sealing member to maintain the fluid-tight relationship therebetween.

6. The clearance seal assembly of claim 5, wherein the static seal is an annular elastomeric seal removably mounted on the sealing member.

7. A pump comprising:

a housing structure having an internal wall defining a suction chamber for containing a fluid;

a piston movably disposed within the chamber; and

a sealing member circumferentially disposed between the housing structure and the piston, the sealing member having a fluid-tight relationship with the housing structure, and the sealing member and the piston defining a continuous and uniform gap, wherein the gap has a size that allows the fluid to fill the gap but prevents the

fluid from flowing through the gap from the suction chamber to an outside of the chamber under an operating fluid pressure.

8. The pump of claim 7, wherein the sealing member and the piston are made of ceramic materials.

9. The pump of claim 7, wherein the housing structure comprises:

a casing defining the suction chamber for accommodating the piston, and

a bearing circumferentially disposed between the piston and the casing.

10. The pump of claim 9, further comprising a static seal disposed between the casing and the sealing member to maintain a fluid-tight relationship therebetween.

11. The pump of claim 10, wherein the static seal is an annular elastomeric seal removably mounted on the sealing member.

ABSTRACT

A clearance seal assembly is disclosed. The assembly comprises a stationary member defining a first side, a second side and an opening connecting the first and second side; a moving member moveably disposed through the opening; and a sealing member circumferentially disposed between the stationary member and the moving member. The sealing member has a fluid-tight relationship with the stationary member. The sealing member and the moving member define a continuous and uniform gap having a size that allows the fluid to fill the gap but prevents the fluid from flowing through the gap from the first side to the second side of the opening under an operating pressure differential between the first and the second side. In a preferred embodiment, both the sealing member and the moving member are made of a ceramic material. The sealing assembly may also include a static seal disposed between the stationary member and the sealing to allow a variable clearance therebetween while maintaining the fluid-tight relationship between the sealing member and the stationary member. A pump utilizing the sealing assembly of the present invention is also disclosed.

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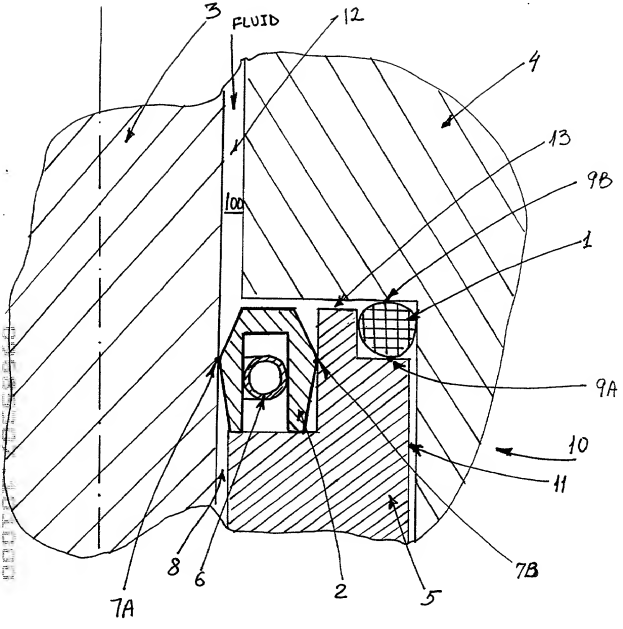

Figure 1

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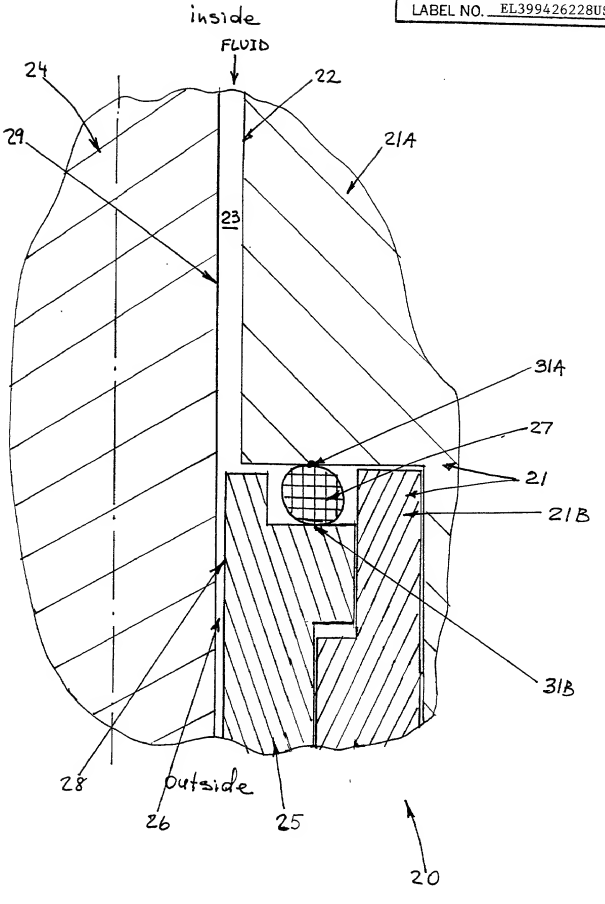

Figure 2

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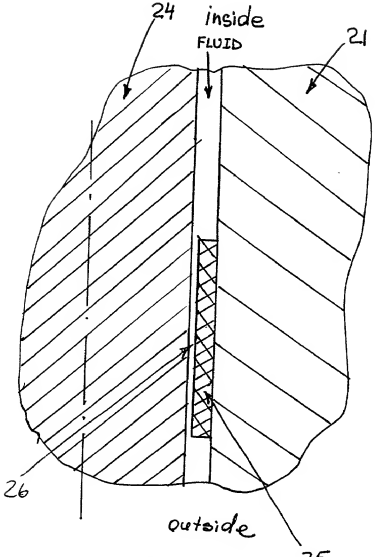

Figure 3

Please type a plus sign (+) inside this box → [X]

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

[X] Declaration Submitted with Initial Filing OR [ ] Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	2028-174
First Named Inventor	Mark J. Kittock
COMPLETE IF KNOWN	
Application Number	/
Filing Date	October 10, 2000
Group Art Unit	
Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

FLUID-MOVING DEVICE WITH A CLEARANCE SEAL

(Title of the Invention)

the specification of which
[XX] is attached hereto
OR
[ ] was filed on (MM/DD/YYYY) [ ] as United States Application Number or PCT International Application Number [ ] and was amended on (MM/DD/YYYY) [ ] (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]

[ ] Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below:

Application Number(s)	Filing Date (MM/DD/YYYY)

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I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number *(if applicable)*

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As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: X Customer Number 22471 → *OR* ☐ Registered practitioner(s) name/registration number listed below

Name	Registration Number	Name	Registration Number

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Direct all correspondence to: ☐ Customer Number or Bar Code Label 22471 *OR* ☐ Correspondence address below

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle (if any))	Family Name or Surname
MARK J.	KITTOCK

Inventor's Signature	Mark J. Kittock					Date	10/4/00
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X Additional inventors are being named on the 1 supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto

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DECLARATION

ADDITIONAL INVENTOR(S)
Supplemental Sheet
Page 1 of 1

Name of Additional Joint Inventor, if any: ☐ A petition has been filed for this unsigned inventor

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City		State		ZIP		Country	

Name of Additional Joint Inventor, if any: ☐ A petition has been filed for this unsigned inventor

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Inventor's Signature						Date	
Residence: City		State		Country		Citizenship	
Post Office Address							
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